THE STRUCTURE AND STRATIGRAPHY OF THE SILURO-DEVONIAN SEDIMENTS OF THE MIDDLE YARRA BASIN, CENTRAL VICTORIA

By Bruce R. Moore
Geology Department, University of Melbourne

Abstract

An account of the structure of the area is given, including descriptions of the major dome and basin structures. The rock units are defined and the sequence of sedimentation given in a geological column.

Introduction

The present work on the Siluro-Devonian is contributed as a further link between the detailed mapping of the Upper Yarra Region and the Walhalla Synclinorium in the E. and the Kinglake, Seymour, and Heathcote areas in the W.

The boundaries of the present work have been chosen so that the sheet will join with the mapping of Williams (1964) and Moore (1965). The work of E. D. Gill in the Lilydale region over the past 20 years has been generously made available, enabling accurate palaeontological control to be exercised on the structural mapping in this region. Likewise the valuable unpublished palaeontological work of Thomas and Kenley has contributed to the structure analysis.

The mapping in this work has been confined to the Palaeozoic sediments, the Palaeozoic igneous boundaries being taken from Hills (1959) and Edwards (1956).

The Tertiary volcanic boundaries of the Woori Yallock Basin are taken from Edwards (1940).

Structure

As in other parts of Central Victoria, the typical N.-S. trend of the Siluro-Devonian fold structures of Central Victoria also dominates this area. The constantly changing plunges are responsible for several major domes and basins. The most prominent of these are the Warrandyte Dome, Lilydale Basin, Macclesfield Dome, and the Killara Basin. Other minor domes and basins occur on the flanks of these structures.

Warrandyte Dome

This large structure was formerly called the Warrandyte Anticlinorium by Jutson (1911b). Recent mapping has revealed the domal nature with strong northerly plunges in the vicinity of Warrandyte and gentle southerly plunges to the S. at Ringwood. The dome has a complex anticlinorial form with numerous small folds dying out along the strike. Two major anticlines dominate the structure at Warrandyte itself. Strong northerly plunges up to 30° are observed to the N. and E. of the dome, on the Yarra R. and the Jumping Ck Rd. Several small folds are present on the E. flank but the dip continues E. towards the Lilydale Basin. The centre of the dome experienced considerable mineralization and valuable gold deposits were mined at Warrandyte. The sediments at the centre of the dome are the oldest to outcrop in the area mapped, with the possible exception of the West Warburton area where both structure and fossils are obscure.

Lilydale Basin

This important structure adjoins the Warrandyte Dome and all the major rock units of the area are exposed in the section W. from the centre of the Warrandyte Dome to Lilydale. The structure is simple in the Croydon area and S. to Rowville, but becomes complex to the N. towards the Yering Gorge crush zone where a large number of minor folds appear on the W. flank of the basin. The basin is approximately 12 miles in length, stretching from Yarra Glen in the N. to Rowville in the S., containing the sediments of the Yering Group, outcropping over a width of some 4 miles at Lilydale. The Cave Hill Limestone Quarry is the geographical and stratigraphic centre of the basin and, unfortunately, much of the E. portion of the basin is obscured by the Dandenong Ranges Igneous Complex. The structure of this portion has to be inferred from the outcrops in the NE. at Coldstream and Yering, since those to the immediate E. of the Dandenong Ra. are obscured by heavy soil cover.

The rocks within the confines of the Lilydale Basin contain rich brachiopod faunas which indicate these sediments to be the youngest in the region, a fact which is fully supported by the structural evidence. Numerous small folds on the W. side of the basin produce repeats of the brachiopod beds in the region of Ruddocks Quarry and the Chirnside Estate at Lilydale.

Three and a half miles to the E. of the main axis of the Lilydale Basin is the prominent plunging synclinal structure of the Yering Basin. The outcrop pattern is seen clearly on the property of 'Yeringberg' where the N. end of the basin is outlined in resistant quartzite. The S. end of the basin is partly obscured by the Dandenongs lavas and heavy soil cover from the Older Basalt outcrops in the region, but the N. plunge of this end can be deduced from outcrops on the W. flank of the important Macclesfield Dome farther E.

Macclesfield Dome

The axis of the dome runs from Emerald in the S., 10 miles N. to Seville. This line is a prominent anticlinal trend since outcrops to the N. indicate an extension to join with the Pauls Range Anticline running through as far N. as Toolangi.

The rock units and the corresponding palaeontological horizons from Lower Silurian can be traced outwards from the centre of the dome until the rich brachiopod faunas of the Devonian are encountered. Only the N. end is visible in outcrop due to intrusion by the pluton in the Gembrook-Cockatoo area. The curves of the strike of outcrop can be traced from Monbulk in the W. to the nose of the fold S. of Seville, where the strata plunge 40° N. with an E.-W. strike. The strikes on the E. flank of the dome can then be traced E. through Yellingbo to Nangana. *Monograptus priodon* occurs at the centre of the dome near Macclesfield and younger strata occur away from the centre until the Yeringian brachiopod faunas are encountered at Yellingbo.

Killara Basin

The Killara Basin lies immediately to the E. of the Macclesfield Dome, having an arcuate form convex to the W. Repeats of the strata at Lilydale are preserved in the basin where richly fossiliferous Yeringian faunas have been recorded by Gill (1940). The S. end of the basin extends S. of Yellingbo towards Nangana, while the N. end disappears under the alluvium of the Yarra valley N. of the junction between the Woori Yallock Ck and the Yarra R.

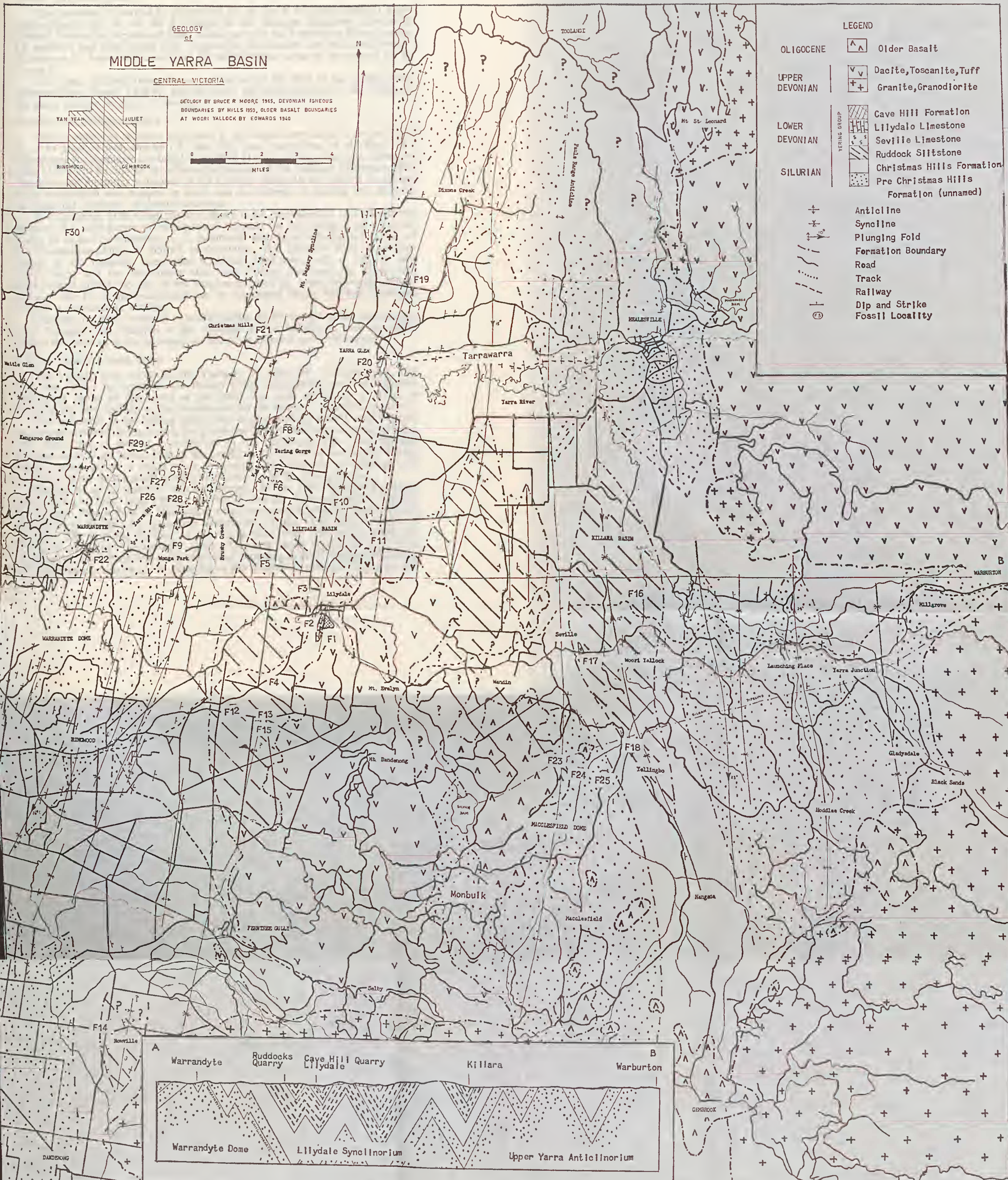
GEOLOGY of MIDDLE YARRA BASIN
CENTRAL VICTORIA
GEOLOGY BY BRUCE R MOORE 1965. DEVONIAN IGNEOUS BOUNDARIES BY HILLS 1959. OLDER BASALT BOUNDARIES AT WOORI YALLOCK BY EDWARDS 1940
YAN YEAN
JULIET
RINGWOOD
GEMBROOK
MILES
N
LEGEND
OLIGOCENE
Older Basalt
UPPER DEVONIAN
Dacite,Toscanite,Tuff
Granite,Granodiorite
LOWER DEVONIAN
YERING GROUP
Cave Hill Formation
Lilydale Limestone
Seville Limestone
Ruddock Siltstone
SILURIAN
Christmas Hills Formation
Pre Christmas Hills Formation (unnamed)
Anticline
Syncline
Plunging Fold
Formation Boundary
Road
Track
Railway
Dip and Strike
Fossil Locality
Toolangi
Mt St Leonard
Dixons Creek
Healesville
Christmas Hills
Yarra Glen
Tarrawarra
Yarra River
Kangaroo Ground
Yering Gorge
Lilydale Basin
Killara Basin
Warrandyte
Monga Park
Lilydale
Warrandyte Dome
Seville
Woori Yallock
Launching Place
Yarra Junction
Warburton
Killgrove
Mt. Evelyn
Wandin
Ringwood
Mt. Dandenong
Macclesfield Dome
Yellingbo
Gladysdale
Black Sands
Hoddles Creek
Monbulk
Macclesfield
Nangana
Ferntree Gully
Selby
Rowville
Dandenong
Gembrook
F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 F13 F14 F15 F16 F17 F18 F19 F20 F21 F22 F23 F24 F25 F26 F27 F28 F29 F30
A
B
Warrandyte
Ruddocks Quarry
Cave Hill Quarry Lilydale
Killara
Warburton
Warrandyte Dome
Lilydale Synclinorium
Upper Yarra Anticlinorium

Fig. 1

Woori Yallock Dome

This structure is marked by plunges of 24° to the S. at Sheep Station Ck and approximately 20° N. on the S. margin of the Acheron Cauldron. Farther E. towards Warburton, repeats of older strata occur in the Launching Place-Hoddles Ck anticline and other small folds. Exposures of structure are concealed towards Warburton by heavy soil cover and the metamorphic zone of the pluton to the S. and E.

The Woori Yallock Dome forms portion of the W. limb of the Upper Yarra Anticlinorium, Moore (1964), but the exact age and structure of the sediments are made obscure by lack of outcrop.

Brushy Creek Escarpment

This prominent escarpment runs from S. of Croydon township, N. to the Yarra R. at its junction with Brushy Ck, then NE. past Yarra Glen to Mt Slide. This escarpment was formerly attributed to faulting (Jutson 1911a), but later shown by Hills (1934) to be due to the differential erosion of the resistant Christmas Hills Quartzite and the softer sediments of the Lilydale Basin. In the present survey the entire escarpment was mapped in detail and no evidence of faulting was detected on either the airphotos or ground structure.

The Christmas Hills Quartzite was shown to be the indurated and coarser top member of a large formation of siltstones. Whether the hardening of the siltstones is due to surface silicification, or to induration associated with the ore bodies of the Warrandyte Dome, is difficult to determine. This quartzite band is overlain always by the relatively impervious Ruddocks Mudstone, both at Lilydale and Yarra Glen, and the Warramate Hills and Yering. The quartzite shows one displacement across the line of the escarpment, and the preservation of younger strata to the E. of the escarpment can be accounted for by the fold structures without a postulate of faulting.

Likewise, no direct evidence of faulting along the W. margin of the Dandenongs Lava Complex was observed in the structure of the Palaeozoic bedrock, either against the lavas or in the structures to the N. at Lilydale and Coldstream.

Yering Gorge Crush Zone

The Yering Gorge occurs on the Yarra R. 2½ miles SW. of Yarra Glen. The river has eroded the gorge in the Brushy Creek Escarpment and this apparent antecedent nature of the Yarra at this point was cited by Jutson (1911a) as evidence for slow faulting as the explanation for the Brushy Creek Escarpment.

The sediments at the Yering gorge have been complexly folded and distorted as a crush zone and strong folding has produced rapidly changing plunge directions. The crush zone is formed in sediments of the Christmas Hills Quartzite and includes some of the lowest beds of the overlying Ruddocks siltstone of the Yering Group, which are of a much softer lithology. This difference of lithology and resistance of the beds has led to differential erosion in the Yering Gorge.

Farther S., at its junction with the Brushy Ck, the Yarra R. enters another gorge at Yarra Park. Hills (1934) postulated that the Yarra adopted a westerly course from Wonga Park to Warrandyte when its original southerly course through Lilydale was blocked by Cainozoic ejectementa of the Older Basalt series at Lilydale. The resulting flooding of the Yarra Glen river flats would cause the Yarra to seek a new higher-level course. This new outlet appears to have been produced at Yarra Park, where the only break occurring in the E.-dipping Christmas Hills Quartzite is due to the N. plunging of the quartzites meeting a S. plunge and preserving an inlier of the softer sediments of the base of the Yering Group. The present analysis of the structure suports the conclusions of Hills (1934) that the Brushy Creek Escarpment results from differential erosion and not faulting, and that the present course of the Yarra through the Wonga Park gorge represented the most favourable outlet for drainage of the inundated tract of the Yarra following the blockage of that stream by volcanic ejectementa at Lilydale.

FOLDING

In general, the folding throughout the area is simple with broad open folds which typify the bedrock structure of the Melbourne area farther to the W. This structure is in marked contrast to the close and complex folding of the Upper Yarra and Walhalla regions and may indicate a difference in mechanism between the two regions.

Stratigraphy

In the present work the rock units of the area will be defined in detail and the thicknesses and lithologies given. Ultimately it is hoped, when the complete results of the present mapping by the author are published, a complete correlation table can be given for Central Victoria. With this in view, the number of new names introduced in this work has been kept to a minimum, since it is certain that many of the rock units, accurately defined here for the first time, will ultimately be extensions of some of those already in the literature.

The following are the detailed descriptions of the rock units from oldest to youngest.

UNNAMED FORMATION (pre-Christmas Hills Formation)

The sediments of this formation are the oldest outcropping in the present area of the Middle Yarra Basin, and underlie the Christmas Hills Formation.

UNIT 1

This unit is not seen in outcrop at the surface but is known to exist on evidence obtained from the workings of the Diamond Creek mine. In the lower levels, the formation of black pyritic slates of this unit was encountered. The fossils recorded indicate the sediments to be the oldest in the present area namely, *Climacograptus* sp. and *Diplograptus* sp.

Samples of this sediment have been obtained from the dumps of the Diamond Creek Mine and include dark coloured siltstones and black pyritic carbonaceous slates which are not represented elsewhere in the area. It is expected that the repeats of this unit will be found when detailed mapping of lithological units is achieved close to the Ordovician-Silurian contacts at Bulla and Sydenham W. of Melbourne.

UNIT 2

The Warrandyte Conglomerate

This unit includes the Warrandyte Conglomerate and the associated grits. These sediments occur in several bands over a thickness of 100 ft in the section, and consist of individual layers from a few inches to about 15 ft in thickness. The rocks vary from fine grits to conglomerate with pebbles up to 4 in. in diameter. The sediments were originally calcareous but much of the material has been leached out. The pebbles in the conglomerates are well rounded and waterworn, whereas the grit particles are angular. The pebbles consist of quartz, quartzite, sandstone, and chert. Outcrops are seen in Whipstick Gully and Andersons Ck S. of Warran-

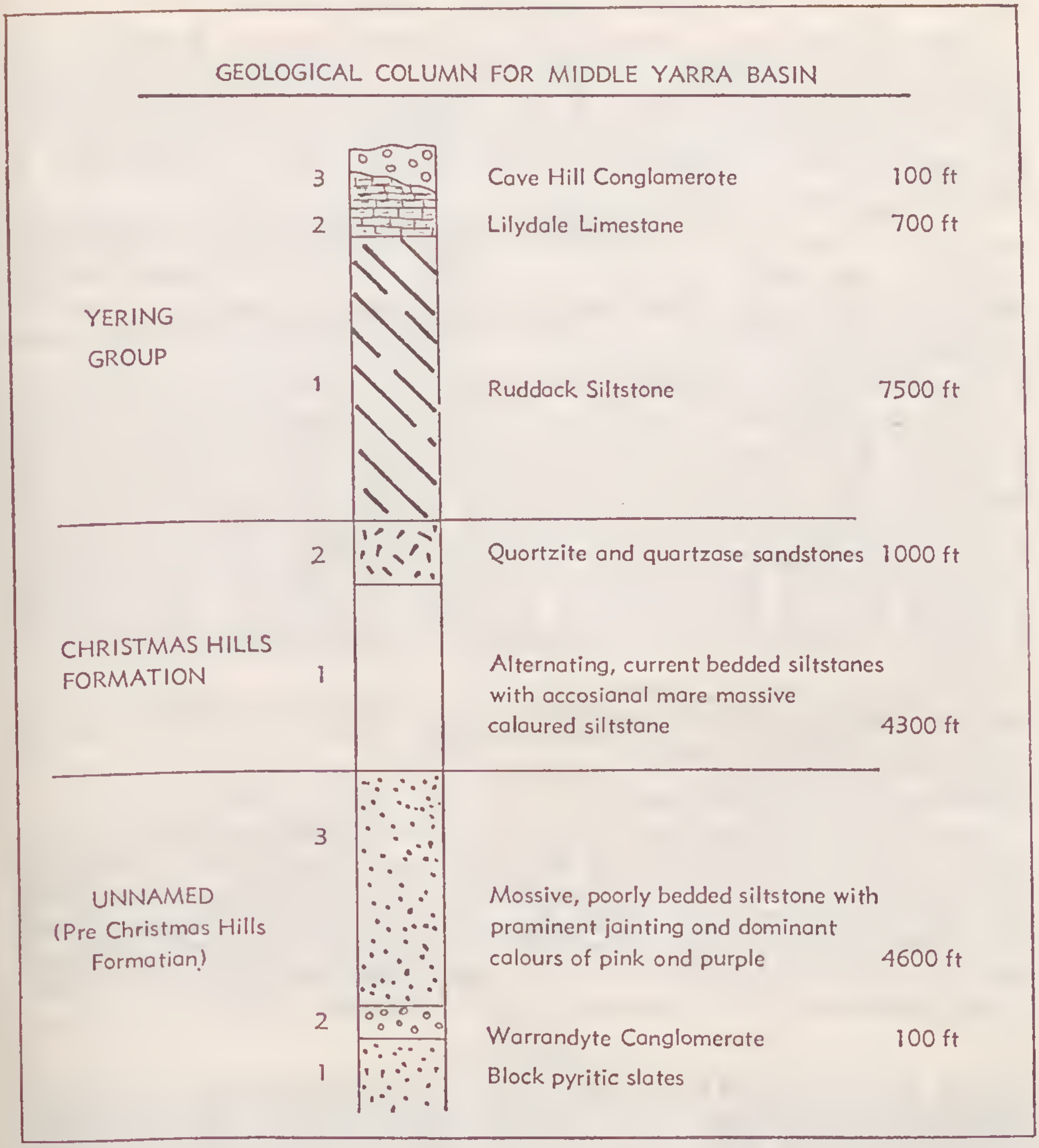

FIG. 2

dyte township. Fragmentary fossils were found by Gill (1940) in a calcareous grit of this unit in the South Warrandyte quarry.

A band of similar calcareous grit with rounded quartz and quartzite pebbles was found N. of Warrandyte on Henley Rd, and may represent a northerly extension of this Unit 2, but could not be traced in the intervening country.

Graptolites have been recorded from William's Quarry at Warrandyte and were identified by Thomas as *M. priodon.* These closely overlie the uppermost bed of the Warrandyte Conglomerate.

Unit 3

This is a widespread series of massive siltstones generally occurring at the axes of the main anticlinal structures. In the Warrandyte region they are a distinctive pink to purple colour in the weathered state, and characteristically micaceous. A very similar lithology is represented in the series at its outcrop at the centre of the Macclesfield Dome where the purple colour of the sediment is distinctive.

In addition to the prominent colour and the micaceous nature of the sediment, this unit can be distinguished by the massive nature of the bedding with thicknesses up to 20 ft, and seldom less than 2 ft. It is difficult to tell the direction of bedding and usually two or three prominent sets of joint planes are present with limonite deposits on their surfaces. At some localities the massive siltstones have occasional interbedded sandstones 3-12 in. thick.

In the Warrandyte area, this Unit 3 is defined as including all the sediments overlying the Warrandyte Conglomerate, Unit 2 of this formation, upwards to the base of the alternating current-bedded siltstones of Unit 1 of the Christmas Hills Formation. This Unit 3 is 3,600 ft thick in the Warrandyte area where the complete unit is exposed on both the E. and W. limbs of the Warrandyte anticlinal structure.

In the Macclesfield Dome the base of the unit is not seen, but all the sediments from the centre of the dome outwards to the N., E. and W. are Unit 3, until the overlying alternating current-bedded siltstones of Unit 1 of the Christmas Hills Formation are encountered. Similarly, the base of the unit is not seen in the Diamond Ck area but the sediments outcrop at the centre of the Diamond Creek Anticline.

The uppermost beds of this Unit 3 contain *Monograptus colonus* at Wonga Park and are closely overlain by the basal beds of the Christmas Hills Formation containing *Monograptus scanicus*.

Christmas Hills Formation

This formation is here extended to include all the sediments overlying the top Unit 3 of the Unnamed Formation, upwards in the section between Warrandyte and Lilydale, to the Christmas Hills Quartzite of Hills (1934). Hence, the original hard quartzitic sediments on the Brushy Ck and Yarra Glen escarpments have been retained as the top unit of the present Christmas Hills Formation and have been shown to be indurated layers of the underlying Unit 1 together with some coarser sandstones. The total thickness of the formation is 5,300 ft.

Unit 1

This consists of 4,300 ft of rapidly alternating siltstones with some sandstones and, generally, with prominent current ripple laminations in the siltstones. Bedding thickness varies from 1-2 in. up to 2 ft and contrasts markedly with the massive bedding of the underlying Unit 3 of the Unnamed Formation. Jointing is generally absent or, if present, is only of a minor nature. The sedimentation of this unit is very distinctive and it has been mapped over a wide area in the present survey. The small scale cross-bedding and current ripple laminations closely resemble those of the Upper Yarra Formation, Moore (1965), and portions of the Yan Yean Formation, Williams (1964).

Unit 2

This unit is approximately 1,000 ft thick overlying Unit 1. It consists of quartzites, some quartzitic sandstones and indurated siltstones showing current ripple laminations. There appear to be facies changes within the unit with the introduction of material coarser than the siltstone range, but in the grade of sandstones. The entire unit has been subjected to strong induration by secondary silica, which does not appear to be due to surface silicification and may have had the same origin as the mineralization of the other portions of the Warrandyte Dome. Further investigation will be necessary to reach a satisfactory conclusion.

The sediments of this Unit 2 are much more resistant to erosion than those of the overlying Yering Group, and have been differentially eroded to produce the prominent Brushy Ck and Yarra Glen escarpments.

Yering Group

This major group of highly fossiliferous sediments in the Lilydale and Yering areas has become well known due to the work of Mr E. D. Gill over the past 20 years. The faunas of these rocks are a welcome contrast to the unfossiliferous nature of the sediments of the underlying Unnamed Formation and, when completely described, may constitute a Devonian section of world significance.

The sediments of the Yering Group are preserved in the major structure of the Lilydale Basin and again in the Killara Basin farther to the E. In the Lilydale Basin the thickness of sediments preserved is between 7,500 and 8,000 ft but cannot be measured completely, since the exact position of the Lilydale syncline is obscured by the unconformable quartzite and conglomerate at Cave Hill and alluvium and the Dandenongs lavas in the surrounding areas. Approximately the same thickness of sediment is preserved in the Killara Basin farther E. of Lilydale, and the rock units have been recently formally named by Gill (1965 MS.).

Unit 1

Ruddocks Siltstone

This unit overlies the uppermost unit of the Christmas Hills Formation, namely the Christmas Hills Quartzite, and extends upward to the base of the Lilydale Limestone at Cave Hill. The unit is 7,500 ft in thickness with massive fine grained siltstones and claystones as the dominant lithological type, together with occasional sandstone bands. The unit is named from the massive poorly bedded sediment in Ruddocks Quarry W. of Edwards Rd, Gill (1940).

The entire unit has fossiliferous bands but those in the upper 3,000 ft are rich in brachiopods, trilobites, and corals.

Unit 2

Lilydale Limestone

This deposit was surveyed in detail by the Mines Department and a report published, Crohn (1953). The limestone forms a lenticular mass striking 16° magnetic and dipping E. at an average angle of 60°. It has been exposed by quarrying operations on the David Mitchell Estate over an area of 600 ft by 1,000 ft and has been proved by boring to extend along the strike for at least 4,000 ft.

The deposit is consistently bedded and appears to be a detrital deposit rather than a true reef formation. The limestone is richly fossiliferous with brachiopods, corals, and crinoids preserved in a matrix of calcite grains and small fossil fragments.

Prominent jointing is a feature of the exposures in the Cave Hill Quarry and at some places the deposit shows evidence of shearing.